Clouds and the Earth's Radiant Energy System (CERES)
(CERES)

Data Management System

CERES Regrid Humidity and Temperature Fields Subsystem
(Subsystem 12.0)

Release 2 Test Plan

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1.0 Introduction

The Clouds and the Earth's Radiant Energy System (CERES) is a key component of the Earth Observing System (EOS). The CERES instruments are improved models of the Earth Radiation Budget Experiment (ERBE) scanner instruments, which operated from 1984 through 1990 on the National Aeronautics and Space Administration's (NASA) Earth Radiation Budget Satellite (ERBS) and on the National Oceanic and Atmospheric Administration's (NOAA) operational weather satellites NOAA-9 and NOAA-10. The strategy of flying instruments on Sun-synchronous, polar orbiting satellites, such as NOAA-9 and NOAA-10, simultaneously with instruments on satellites that have precessing orbits in lower inclinations, such as ERBS, was successfully developed in ERBE to reduce time sampling errors. CERES will continue that strategy by flying instruments on the polar orbiting EOS platforms simultaneously with an instrument on the Tropical Rainfall Measuring Mission (TRMM) spacecraft, which has an orbital inclination of 35 degrees. In addition, to reduce the uncertainty in data interpretation, and to improve the consistency between the cloud parameters and the radiation fields, CERES will include cloud imager data and other atmospheric parameters. The first CERES instrument is scheduled to be launched on the TRMM spacecraft in 1997. Additional CERES instruments will fly on the EOS-AM platforms, the first of which is scheduled for launch in 1998, and on the EOS-PM platforms, the first of which is scheduled for launch in 2000.

1.1 Document Overview

This document, the CERES Release 2 Delivery Test Plan for the CERES Regrid Meteorological, Ozone, and Aerosol (MOA) Subsystem (Subsystem 12), provides a description of the CERES Regrid Meteorological, Ozone, and Aerosol Subsystem Release 2 software and supporting data files, and explains the procedures for installing, executing, and testing the software. A section is also included on validating the results of executing the software.

The document is organized as follows:

1.2 Subsystem Overview

The CERES Regrid MOA Subsystem ingests meteorological, ozone, and aerosol data from several different external sources and combines these data into one file, the MOA file. The Regrid MOA Subsystem executes once per day, and produces 24 hourly MOA files. Since the input data from the different external sources do not conform to a common spatial and temporal grid system, this

Subsystem spatially and temporally interpolates the input aerosol and ozone data to conform to the same horizontal grid as the meteorological data. Microwave humidity data, however, is retained on its original input grid. Software developed by the CERES Clouds, Surface and Atmospheric Radiation Budget (SARB), and Time Interpolation and Spatial Averaging (TISA) Working Groups all require access to the data contained in the MOA.

For the initial delivery of the Regrid MOA Subsystem software to the Langley Distributed Active Archive Center (DAAC), the CERES SARB Working Group is providing the input data sets. For postlaunch processing, however, the Langley TRMM Information System (LaTIS) is responsible for obtaining the external ancillary input data required by this Subsystem. LaTIS will perform the initial ingestion of these data. The spatial and temporal resolutions of these data will not be altered. LaTIS will provide a scheduler that will track the availability of these input data sets and subsequently control processing of Product Generation Executives (PGE) such as the Regrid MOA Subsystem. The CERES Science Team will decide on an allowable lag time between the measurement of CERES data and the execution of this Subsystem. This lag time should be built into the processing scheduler, and should allow for the accumulation of the necessary input data from the external sources. If microwave humidity data are not available from the external source after this lag time, the Regrid MOA Subsystem may access a climatology approved by the CERES Science Team. Likewise, if the ozone data from neither the primary or secondary source for a given day are not available within the allowable lag time, the most recent ozone data file may be used.

This subsystem first interpolates the ozone and aerosol input data horizontally, which is the domain where the data have the smallest variability. The aerosol optical depth data requires neither temporal nor vertical interpolation. The ozone data also require no temporal interpolation, but if the backup source, EP-TOMS, is used, vertical interpolation of the column ozone data is necessary to obtain the ozone mixing ratio profile. Next, the nonmicrowave meteorological data are temporally interpolated. The meteorological profile data--temperature, specific humidity, and wind speed vectors--are interpolated in the vertical domain where the data have the largest variability. Data interpolated in the vertical domain provide vertical profiles at pressure levels selected by the CERES Science Team. While the microwave humidity data are neither horizontally nor vertically interpolated, they are temporally interpolated to provide hourly data. This temporal interpolation requires data from both the previous and succeeding days, and from the backup climatology.

External products that the Regrid MOA Subsystem will access in Release 2 include National Centers for Environmental Prediction (NCEP) Stratospheric Monitoring Group Ozone Blended Analysis (SMOBA) ozone data (primary source) or TOMS-EP ozone data (secondary source), meteorological data, such as temperature, humidity, and wind speed profile data, obtained from the Data Assimilation Office (DAO) at Goddard Space Flight Center, and SSM/I microwave humidity data obtained from the Global Hydrology Resource Center (GHRC) at NASA Marshall. CERES will provide the input climatological data sets for aerosol optical depth and microwave water vapor at the time of software delivery. Updates to these climatological data sets are planned prior to post-launch processing.

2.0 Test Environment

2.1 External Interface Requirements

The input data provided for the Regrid MOA testing contains sample data sets obtained from the various external suppliers. Changes in the DAO external interfaces are expected prior to the TRMM launch, resulting in the need for a redelivery of the Regrid MOA Subsystem software that ingests those data.

The CERES Library (CERESlib) Fortran 90 modules used by the Regrid MOA Subsystem software are listed in Table 2-1.

Table 2-1. CERESlib Routines Used by the Regrid MOA Subsystem

File Name	Description
ceres_defaults	Provides system-defined CERES default values
ceres_meteor	Provides commonly used mathematical routines
ceres_status	Provides a common set of file and return statuses
f90_kind	Provides F90 compiler-specific KIND values
io	Provides Toolkit IO wrappers
meta_util	Provides Toolkit MetaData wrappers
moa_io	Provides MOA data structure and I/O routines
msg	Provides interface to the SMF Toolkit
PCF	Provides an interface to the PCF file
QCheader	Provides utilities for writing QC header
reference_grid	Provides an interface to the CERES reference grid

2.2 Directory Structure and File Descriptions

In addition to the tar file containing this document, the CERES Regrid SARB Subsystem Release 2 delivery package will contain three compressed tar files and one uncompressed tar file. RegridMOA_src.tar.Z contains FORTRAN source code, error message files, and other formatted files necessary for Subsystem execution. RegridMOA_anc.tar.Z contains the ancillary input data sets, formatted and binary, necessary for Subsystem execution. RegridMOA_exp.tar.Z contains 24 hourly binary MOA files generated at the Science Computing Facility (SCF) for comparison against the MOA files generated by the Langley DAAC during Subsystem Integration and Testing (SSI&T). The last tar file, RegridMOA_input.tar, contains the input data, which are flat binary files, and is not compressed, The directory structures of the untarred files are shown in Appendix B. The contents of the tar files are categorized according to software files and input and output

data file types. A description of the contents of each file included in the delivery package can be found in Tables C.1-1 through C.9-1 in Appendix C.

3.0 Software/Data File Installation Procedure

This section describes how to install the Regrid MOA Subsystem software in preparation for making the necessary test runs at the Langley DAAC. The installation procedures include instructions for uncompressing and untarring the SARB Regrid MOA files, properly defining environmental variables, and recompiling the SARB Regrid MOA programs.

3.1 Installation

1. The scripts, makefiles, and Process Control File in the Regrid MOA Subsystem delivery package expect the CERES environment variable, $CERESENV, to point to a file which sets the following environment variables:

   PGSDIR - Directory for Toolkit libraries
   F90 - Pointer to the F90 compiler
   CERESHOME - Top Directory for CERES Software
   CERESLIB - Directory for CERESlib
   PGSMSG - Directory which contains Toolkit and CERES Status Message Files

2. Change directory to the directory where you plan to install the Regrid MOA

   Subsystem. (The following instructions assume that the directory will be **$CERESHOME**).

3. Uncompress and untar the tar files by typing the following commands:

   ```
   > uncompress RegridMOA_src_R2-057.tar.Z
   > tar xf RegridMOA_src_R2-057.tar
   > uncompress RegridMOA_anc_R2-057.tar.Z
   > tar xf RegridMOA_anc_R2-057.tar
   > uncompress RegridMOA_data_R2-057.tar.Z
   > tar xf RegridMOA_data_R2-057.tar
   > uncompress RegridMOA_exp_R2-057.tar.Z
   > tar xf RegridMOA_exp_R2-057.tar
   ```

3.2 Compilation

1. **MOA_Gen.exe**, the executable for the Regrid MOA Subsystem, is not provided on the tarfile. To create the executable on directory **$CERESHOME/sarb/bin/regridmoa**, type the following commands:

```
> source $CERESENV
> cd $CERESHOME/sarb/smf/regridmoa
> make
> cd $CERESHOME/sarb/src/regridmoa
> make
```

4.0 Procedures for Testing the Software

This section provides general information on how to execute the SARB Regrid MOA Subsystem and provides an overview of the test and evaluation procedures. It includes a description of what is being tested and the order in which the tests should be performed.

4.1 Stand-alone Test Procedures

Execute the production script by typing the script name, followed by the date parameter in format, YYYYMMDD, where YYYY is the 4-digit year, MM is the 2-digit month, DD is the 2-digit day.

1. For the Main Processor test, using runmoa and 12/18/1997 data, type:

   > **cd $CERESHOME/sarb/bin/regridmoa**
   > **runmoa 19980103**

   The PGE, MOA_Gen.exe, will be executed and will create:

   $CERESHOME/sarb/data/out_comp/data/regridmoa/
   CER_MOA_CERES_ValidationR1_000000.19980103hh,
   $CERESHOME/sarb/data/out_comp/data/regridmoa/
   CER_MOA_CERES_ValidationR1_000000.19980103hh.met,
   where "hh" ranges from "00" to "23"

   $CERESHOME/sarb/data/out_comp/QA_reports/
   CER_PQCR_CERES_ValidationR1_000000.19980103
   $CERESHOME/sarb/data/out_comp/QA_reports/
   CER_PQCR_CERES_ValidationR1_000000.19980103.met

   Subsystem Test Summary (from UNIX time command):

   1676.567u 31.381s 29:17.52 97.1% 0+0k 36031+29io 4pf+0w

4.2 Normal Operating Procedures

Before CERES Regrid MOA Subsystem can be executed in production, input for the appropriate day of data must be available from the external sources.

4.3 Evaluation Procedures

4.3.1 Exit Codes

The status of Regrid MOA Subsystem is captured immediately after the executable command has completed. If this status is equal to zero, then the executable completed without any problems and a value of zero is assigned to the PGE_EXIT environment variable. If the status is anything other then zero, a value of 203 is given to the PGE_EXIT environment variable.

4.3.2 Log and Status File Results

The Error and Status Log file, LogReport, will be located in directory $CERESHOME/sarb/data/runlogs/regridmoa after CERES Subsystem 12.0 has been executed. Information contained in this log file can be compared to the expected contents of the LogReport found in directory $CERESHOME/sarb/data/out_exp/comp_data/regridmoa.

4.3.3 Execution of Comparison Software

This section provides the procedure for evaluating the output from the SARB Regrid MOA Subsystem.

1. The executable for the comparison software is not provided in the tar file. To create the executable on directory **$CERESHOME/sarb/test_suites/bin/regridmoa**, type the following commands:

   > **source $CERESENV**
   > **cd $CERESHOME/sarb/test_suites/src/regridmoa**
   > **make**

2. Execute the script to run comparison software:

   > $CERESHOME/sarb/test_suites/bin/regridmoa/moacomp.exe

   One file will be created:

   >$CERESHOME/sarb/test_suites/bin/regridmoa/Compare_MOA.txt

4.3.4 Evaluation of Comparison Software Output

1. Examine the comparison report file

>more $CERESHOME/sarb/test_suites/bin/regridmoa/Compare_MOA.txt

If all goes well, the Compare_MOA.txt file will show only the processing data of both files for each hour being produced by the Langley DAAC with those produced by the CERES team.

2. E-mail the file **$CERESHOME/sarb/test_suites/bin/regridmoa/Compare_MOA.txt** to Ed Kizer, e.a.kizer@larc.nasa.gov
3. Solutions to Possible Problems
   All output files, MOA data files, MOA MetaData files and QC reports, are opened with Status = NEW in Subsystem 12.0 software. These files must be removed before rerunning these test procedures.

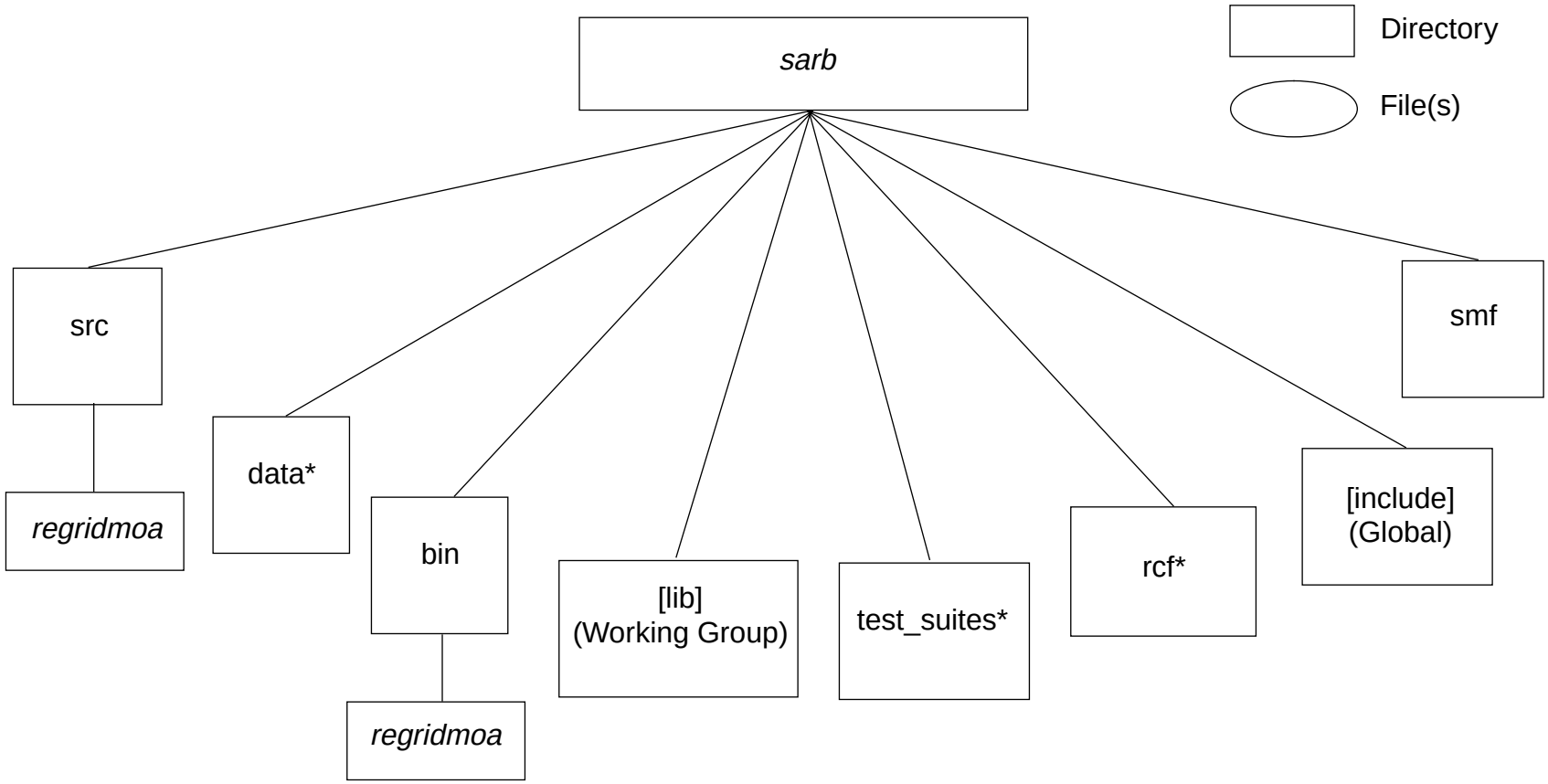
APPENDIX A
Acronyms and Abbreviations

Appendix A
Acronyms and Abbreviations

CERES	Clouds and the Earth's Radiant Energy System
CERESlib	CERES Library
DAAC	Distributed Active Archive Center
DAO	Data Assimilation Office
ECS	EOSDIS Core System
EOS	Earth Observing System
EOS-AM	EOS Morning Crossing Mission
EOSDIS	EOS Data Information System
EOS-PM	EOS Afternoon Crossing Mission
ERBE	Earth Radiation Budget Experiment
ERBS	Earth Radiation Budget Satellite
GHRC	Global Hydrology Resource Center
LaTIS	Langley TRMM Information Center
MCF	Metadata Control Files
MOA	Meteorological, Ozone, and Aerosol
NASA	National Aeronautics and Space Administration
NCEP	National Centers for Environmental Prediction
NOAA	National Oceanic and Atmospheric Administration
PCF	Process Control File
PGE	Product Generation Executive
QC	Quality Control
SARB	Surface and Atmospheric Radiation Budget
SMF	Status Message Files
SMOBA	Stratospheric Monitoring Group Ozone Blended Analysis
SSI&T	Subsystem Integration and Testing
TISA	Time Interpolation and Spatial Averaging
TRMM	Tropical Rainfall Measuring Mission

APPENDIX B
Directory Structure Diagram

BREAKDOWN OF THE SARB REGRID MOA DIRECTORY

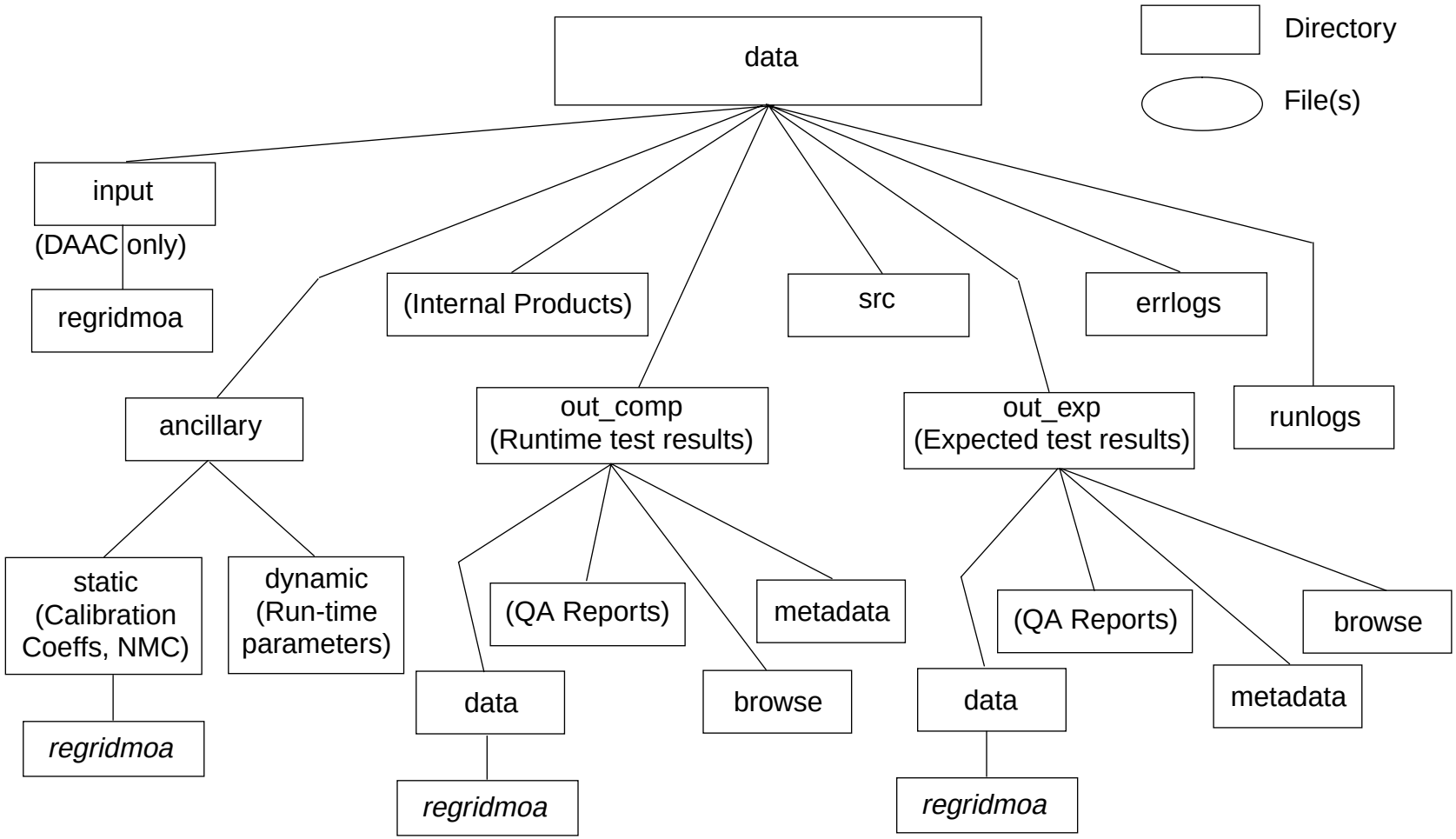


Italicized names are dependent on delivered software
*Breakdown of subdirectories shown on following pages

Names in brackets [ ] are optional files or directories

Figure B-1. SARB Regrid MOA Delivery Directory Structure (1 of 4)

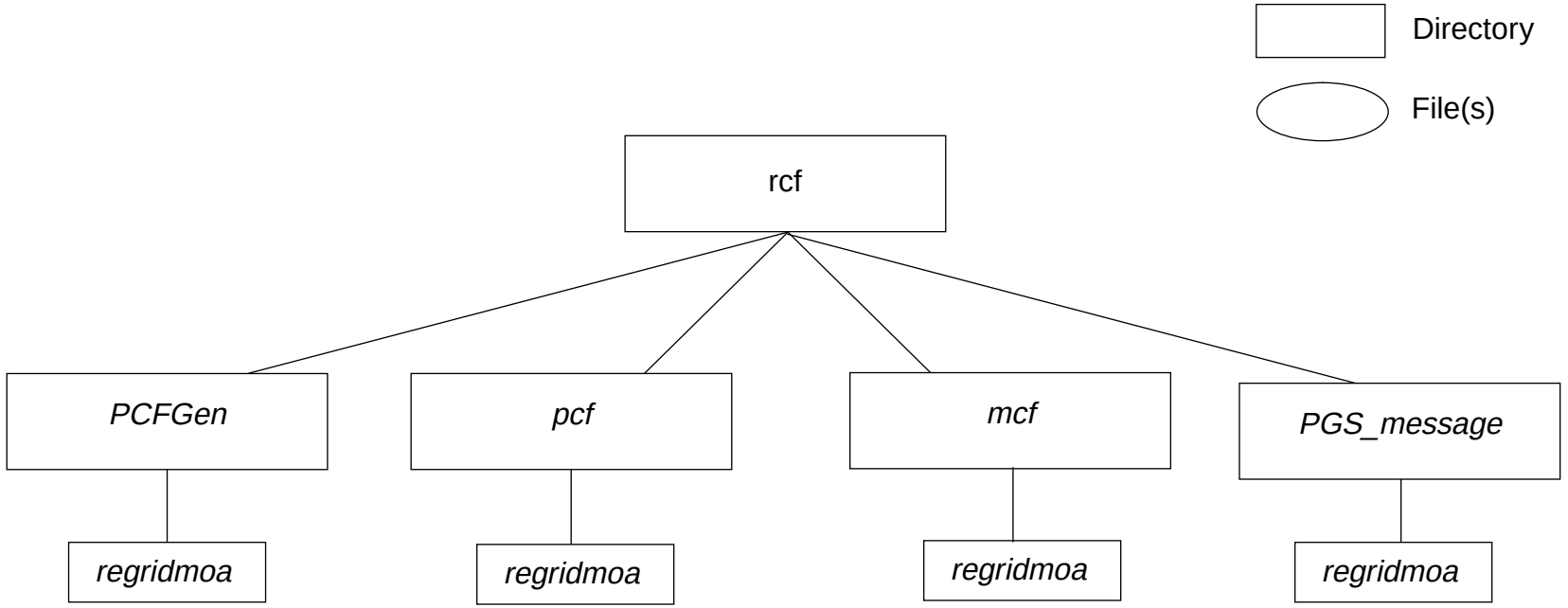
BREAKDOWN OF THE DATA DIRECTORY



Italicized names are dependent on delivered software

Figure B-1. SARB Regrid MOA Delivery Directory Structure (2 of 4)

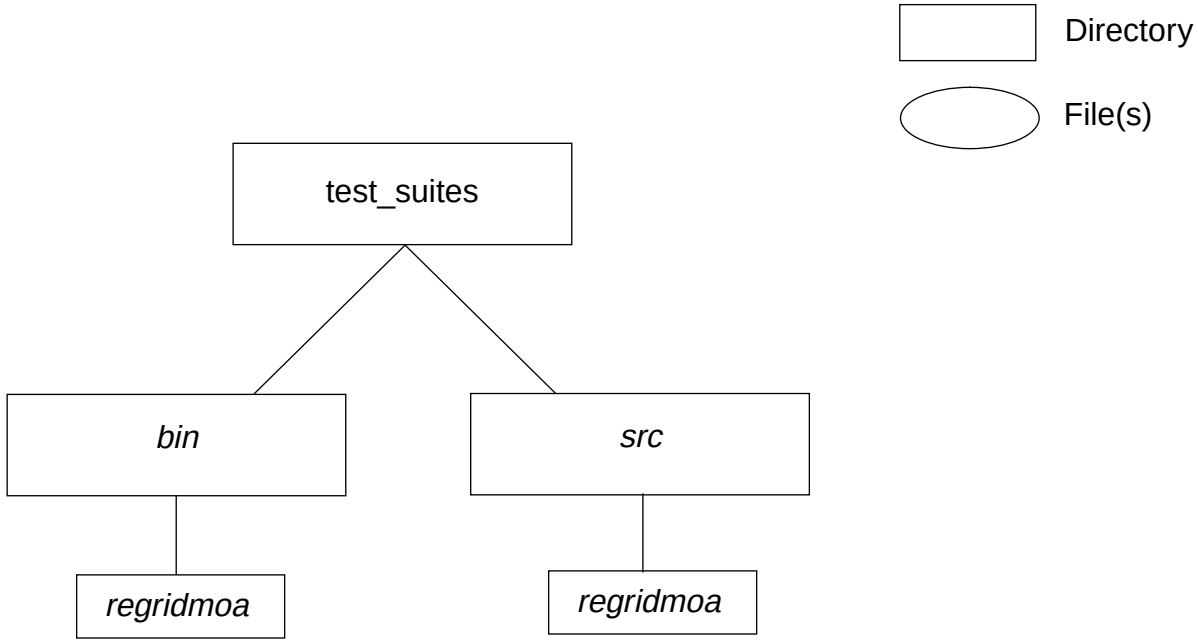
BREAKDOWN OF THE RCF DIRECTORY STRUCTURE



Italicized names are dependent on delivered software

Figure B-1. SARB Regrid MOA Delivery Directory Structure (3 of 4)

BREAKDOWN OF THE TEST_SUITES DIRECTORY STRUCTURE



Italicized names are dependent on delivered software

Figure B-1. SARB Regrid MOA Delivery Directory Structure (4 of 4)

APPENDIX C
File Description Tables

C.1 Production Script and Executable

Table C.1-1. Script and Executable

File Name	Format	Description
runmoa	ASCII	C-Shell script which executes Regrid MOA Subsystem
moa_ascii_gen.csh	ASCII	C-Shell script which executes an ASCII file generator for the PCF Generator
moa_pcfgen.csh	ASCII	C-Shell script which executes a PCF Generator
MOA_Gen.exe[a]	Binary	Subsystem executable

a. This file will be generated on execution of production software and is not included in the tar file

C.2 Processing Control Files (PCF), Metadata Control Files (MCF) and Status Message Files (SMF)

With the initial delivery of the Regrid MOA Subsystem, metadata is not included. Metadata will be included as soon as the CERESlib routines that provide wrappers to the Toolkit rotuines are in place.

Table C.2-1. Processing Control Files (PCF), Metadata Control Files (MCF) and Stats Message Files (SMF) (1 of 2)

File Name	Format	Description
PGS_26500[a]	ASCII	Toolkit Status Message File
PGS_26501[a]	ASCII	Toolkit Status Message File
PGS_26502[a]	ASCII	Toolkit Status Message File
PGS_26503[a]	ASCII	Toolkit Status Message File
PGS_26504[a]	ASCII	Toolkit Status Message File
PGS_26505[a]	ASCII	Toolkit Status Message File
PGS_26506[a]	ASCII	Toolkit Status Message File
PGS_26507[a]	ASCII	Toolkit Status Message File
PGS_26508[a]	ASCII	Toolkit Status Message File
PGS_26509[a]	ASCII	Toolkit Status Message File
PGS_26510[a]	ASCII	Toolkit Status Message File

Table C.2-1. Processing Control Files (PCF), Metadata Control Files (MCF) and Stats Message Files (SMF) (2 of 2)

File Name	Format	Description
PGS_26511[a]	ASCII	Toolkit Status Message File
PGS_26512[a]	ASCII	Toolkit Status Message File
PGS_26513[a]	ASCII	Toolkit Status Message File
PGS_26514[a]	ASCII	Toolkit Status Message File
PGS_26515[a]	ASCII	Toolkit Status Message File
CER12.1P1_PCFin_CERES_ValidationR1_000000.19980103	ASCII	Ascii file for input to pcf generator
CER12.1P1_PCF_CERES_ValidationR1_000000.19980103	ASCII	Regrid MOA PCF File

a. These files are not included in the tar file

C.3 Production Source Code and Makefile

Table C.3-1. Fortran 90 Main Processor Source Code (1 of 2)

File Name	Format	Description
AEROSOLS_MOD.f90	ASCII	Processes aerosol data
AirCalc_Mod.f90	ASCII	Determines air mass index
COL_OZONE.f90	ASCII	Processes ozone data
DAO1_MOD.f90	ASCII	Drives ingestion and processing of DAO meteorological input data
DAO_Main2.f90	ASCII	Contains interpolation routines for processing of DAO meteorological input data
DAO_Params.f90	ASCII	Contains parameters required to process DAO meteorological input data
Grid_Params.f90	ASCII	Contains parameters required by the gridding process
Grid_Setup.f90	ASCII	Contains routines necessary for gridding to the MOA output grid
Horiz_Inter.f90	ASCII	Converts data on one horizontal grid to another horizontal grid
Init_MOA.f90	ASCII	Contains initialization routines
Job_Params.f90	ASCII	Contains parameters associated with the job request, i.e., data date and time

Table C.3-1. Fortran 90 Main Processor Source Code (2 of 2)

File Name	Format	Description
MOA_Main.f90	ASCII	Regrid MOA Subsystem main program
MOA_IO.f90	ASCII	Contains MOA data structure and I/O routines
MOA_LOGID.f90	ASCII	Parameter module of logic IDs for input and output files
MOA_Var.f90	ASCII	Contains type declarations for variables used throughout the Regrid MOA Subsystem
MW_H2O.f90	ASCII	Drives processing of microwave humidity data
NCEP_Ingest.f90	ASCII	Ingests NCEP (backup source) meteorological data
NCEP_Main2.f90	ASCII	Drives processing of NCEP data
PostProc.f90	ASCII	Drives processing of QC reports and MetaData
SAGE_Replace.f90	ASCII	Vertically and horizontally interpolates SAGE data to the output grid
Temp_Humid.f90	ASCII	Temporally and vertically interpolates temperature and humidity data
gbytes.c	ASCII	Extracts requested number of bytes from a word
ggrtch_mod.f90	ASCII	Contains needed mathematical formulas
sphertlib3.f90	ASCII	Converts NCEP wave data to data on a Guassian grid
Makefile	ASCII	Makefile to produce executable

C.4 Ancillary Input Data

Table C.4-1. Ancillary Input Data

File Name	Format	Description
GridParams_SS12	Formatted Namelist	Sizes and region counts for all of the grids used in the Regrid MOA Subsystem
RegCenters_SS12	Binary	Latitudinal and longitudinal coordinates of the CERES and Guassian grids
Ozwts_mmm mmm = jan ... dec	ASCII	Monthly Zonal and pressure level dependent weighting factors for generating a vertical ozone profile
NVAP_SSMIclim	Binary	Backup microwave climatological data set
Pink_Stow_mm mm = 01 .. 12	Binary	Monthly Aerosol climatological data set
SAGE_WV_sss sss = spr, sum, aut, win	Bianry	Seasonal SAGE water vapor climatology data set

C.5 Primary Input Data

Only the files required to process October 1, 1986, in the test environment are included in the initial Release 2 delivery package. An additional delivery of input files is required prior to processing the remaining days of the month.

Table C.5-1. Primary Input Data (1 of 2)

File Name	Format	Description
ceres_dao_trmm.pave.yyyymmdd[a]	Binary	DAO 2x2.5 3-hourly surface pressure data
ceres_dao_trmm.phis.yyyymmdd[a]	Binary	DAO 2x2.5 6-hourly surface geopotential data
ceres_dao_trmm.ps.yyyymmdd[a]	Binary	DAO 2x2.5 6-hourly surface pressure data
ceres_dao_trmm.q10m.yyyymmdd[a]	Binary	DAO 2x2.5 3-hourly specific humidity at 10 meters
ceres_dao_trmm.sphu.yyyymmdd[a]	Binary	DAO 2x2.5 6-hourly specific humidity profile data
ceres_dao_trmm.t10m.yyyymmdd[a]	Binary	DAO 2x2.5 3-hourly temperature at 10 meters
ceres_dao_trmm.tg.yyyymmdd[a]	Binary	DAO 2x2.5 6-hourly ground temperature data
ceres_dao_trmm.tmpu.yyyymmdd[a]	Binary	DAO 2x2.5 6-hourly temperature profile data

Table C.5-1. Primary Input Data (2 of 2)

File Name	Format	Description
ceres_dao_trmm.tropp.yyyymmdd[a]	Binary	DAO 2x2.5 6-hourly tropopause level data
ceres_dao_trmm.u10m.yyyymmdd[a]	Binary	DAO 2x2.5 3-hourly u wind speed vector at 10 meters
ceres_dao_trmm.uwnd.yyyymmdd[a]	Binary	DAO 2x2.5 6-hourly u wind speed vector profile data
ceres_dao_trmm.v10m.yyyymmdd[a]	Binary	DAO 2x2.5 3-hourly v wind speed vector at 10 meters
ceres_dao_trmm.vwnd.yyyymmdd[a]	Binary	DAO 2x2.5 6-hourly v wind speed vector profile data
f13_iwva_98002_dayAD.hdf	HDF	SSM/I microwave humidity data
f13_iwva_98003_dayAD.hdf	HDF	SSM/I microwave humidity data
f13_iwva_97004_dayAD.hdf	HDF	SSM/I microwave humidity data
oz980102.dat	ASCII	SMOBA ozone data
oz980103.dat	ASCII	SMOBA ozone data

a. yyyymmdd = 19980103 & 19980104

C.6 Output Data Files (Expected Results)

Table C.6-1. Output Data Files (Expected Results)

File Name	Format	Description
CER_MOA_CERES_ValidationR1_00000.19980103hh[a]	Binary	The 24 hourly MOA output files
CER_MOA_CERES_ValidationR1_00000.19980103hh.met[a]	ASCII	The 24 hourly MOA MetaData files

a. hh = 00 .. 23

C.7 Output Data Files (Production Results)

With the initial delivery of the Regrid MOA Subsystem, metadata is not included. Metadata will be included as soon as the CERESlib routines that provide wrappers to the Toolkit rotuines are in place.

Table C.7-1. Output Data Files (Production Results)

File Name	Format	Description
CER_MOA_CERES_ValidationR1_000000.19980103hh[a]	Binary	The 24 hourly MOA output files
CER_MOA_CERES_ValidationR1_000000.19980103hh.met	ASCII	The 24 hourly MOA Metadata files
CER_PQCR_CERES_ValidationR1_000000.19980103	ASCII	The QC Report file
CER_PQCR_CERES_ValidationR1_000000.19980103.met	ASCII	The QC Report file Metadata file

a. hh = 00 .. 23

C.8 Output Temporary Data Files (Production Results)

Not Applicable

C.9 Error and Status Message Files (Expected Results)

These files will be generated on execution of Subsystem software and are not included in the tar file.

Table C.9-1. Error and Status Message Files

File Name	Format	Description
CER12.1P1_LogReport_CERES_ValidationR1_000000.19980103	ASCII	Report Log
CER12.1P1_LogStatus_CERES_ValidationR1_000000.19980103	ASCII	Status Log
CER12.1P1_LogUser_CERES_ValidationR1_000000.19980103	ASCII	Log for User Messages